Claims

1. A refrigeration system including a refrigerant circuit (**15**) in which a compressor (**50**), a gas cooler (**16**), an expander (**60**) and an evaporator (**17**) are connected, the refrigeration system operating in a refrigeration cycle having a high-side refrigerant pressure equal to or above the critical pressure of the refrigerant by circulating the refrigerant through the refrigerant circuit (**15**), wherein

the compressor (**50**) and the expander (**60**) are each composed of a displacement fluid machine whose fluid chamber is variable in volume and are connected one to the other with the rotational speed ratio of the one to the other fixed, and

the volume v_2 of the fluid chamber in the expander (**60**) just after the closing off of fluid communication from an inlet channel thereof is set to $v_2=\rho_1 v_1 r/\rho_2$ and the volume v_3 of the fluid chamber in the expander (**60**) just before the provision of fluid communication with an outlet channel thereof is set to $v_3=\rho_2 v_2/\rho_3$, where:

the low-side refrigerant pressure of the refrigeration cycle and the refrigerant temperature at the exit of the gas cooler (**16**) under reference operating conditions serving as a design standard are employed as a reference low pressure and a reference refrigerant temperature, respectively;

the high-side refrigerant pressure of the refrigeration cycle at which the coefficient of performance of the refrigeration cycle reaches a maximum value under the reference operating conditions is employed as a reference high pressure;

ρ_1 is the density of saturated gas refrigerant at the reference low pressure;

ρ_2 is the density of refrigerant at the reference high pressure and the reference refrigerant temperature;

ρ_3 is the density of refrigerant adiabatically expanded from a condition of the reference high pressure and the reference refrigerant temperature into a condition of the reference low pressure;

v_1 is the volume of the fluid chamber in the compressor (**50**) just after the closing off of fluid communication from a suction channel thereof; and

r is the rotational speed ratio of the compressor (**50**) to the expander (**60**).

2. The refrigeration system of claim 1, wherein the refrigerant circuit (**15**) is provided with a receiver (**18**) between the exit side of the evaporator (**17**) and the suction side of the compressor (**50**).

3. The refrigeration system of claim 1, wherein the refrigerant circuit (**15**) is provided with an internal heat exchanger (**20**) for providing heat exchange between refrigerant flowing from the gas cooler (**16**) towards the expander (**60**) and refrigerant flowing from the evaporator (**17**) towards the compressor (**50**).